METABOLISM IN DEMENTIA PRAECOX*

ELLISON L. ROSS, PH.D.
HOSPITAL, ILL.

The findings reported in this paper are the result of work suggested by Dr. H. D. Singer, director of the institute, and begun by A. F. Wussow in this laboratory. Pighini[1] and Statuti[2] claimed from their data that the metabolism of dementia praecox was not normal. Wussow[3] and Barnes[4] did not obtain results that confirmed the findings of Pighini and Statuti. Folin[5] found no evidence of an abnormal metabolism in dementia praecox.

TESTS

The plan of the tests was to determine the income and the outgo of nitrogen, sulphur, phosphorus, calcium and magnesium in cases of dementia praecox. Tests were made at various times of the year and various diets were used (Table 1).

The method of preparing and preserving the food used in these tests made it possible to have but one sample of food for analysis and to give the patient a constant diet. For example, when hamburger was used as a part of the diet, sufficient very finely ground hamburger was cooked and then again very finely ground and mixed. Weighed amounts sufficient for a meal were put in ice-cream boxes and stored in a room which was maintained below 0 C. (32 F.). In the preparation of a meal one package of hamburger was put into a bowl with a small amount of water, set in a steam oven and warmed. Coffee, when used, was prepared by making up a liter or more of a very concentrated solution of commercial soluble coffee. Ten cubic centimeters of this were sufficient to make two cups of coffee. This amount was put into a pitcher with 20 c.c. of condensed milk and when the meal was ready to take to the ward, a couple of cups of boiling distilled water were added to each pitcher.

There were many difficulties to be overcome in doing metabolism work in cases of dementia praecox. One of the difficulties was with the feces. Cases of chronic or temporary constipation were frequently met.

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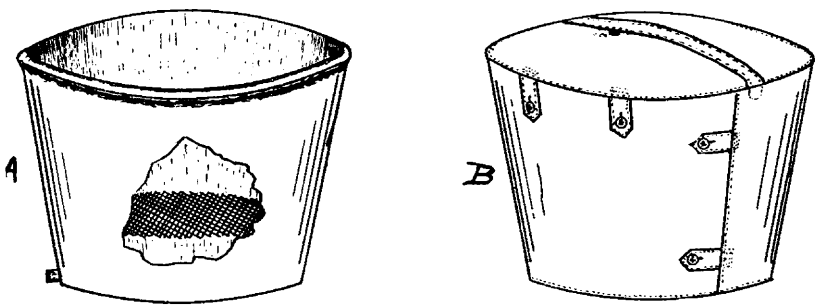
1. Pighini: Arch. Neurol. and Psychiat., 1909, iv, 220.
2. Statuti: Am. Jour. Insanity, 1910, lxvii, 299.
3. Wussow: Institution Quarterly of Illinois, March 31, 1913, p. 71.
4. Barnes: Am. Jour. Insanity, 1909, lx, 591.
5. Folin, quoted by Wussow: The Institution Quarterly of Illinois, March 31, 1913.

TABLE 1.—Daily Diet in Metabolism Tests in Five Cases of Dementia Praecox

Patient	Preliminary Test	Test Proper	Breakfast	Dinner	Supper
G. G.	Sept. 30-Oct. 4	Oct. 4-10	Graham crackers, peanut butter, butterine, agar.	Same as breakfast.	Same as breakfast.
A. S.	Dec. 13-14	Dec. 14-20	Rice (boiled with milk), jelly (containing English walnuts), sugared agar.	Omelet (of ham, egg, cheese and milk), sugared agar.	Same as breakfast.
M. P.	Feb. 4-10	Feb. 10-15	(Ham - egg - cheese - milk) - omelet, graham crackers, peanut butter, butterine, agar, milk.	Same as breakfast.	Same as breakfast.
S. K.	Aug. 16-21	Aug. 21-29	Soda crackers, peanut butter, agar sauce.	Soda crackers, hamburger, agar sauce.	Graham crackers, peanut butter, agar sauce.
F. L.	Nov. 13-27	Nov. 27-Dec. 4	Coffee, condensed milk, egg omelet, graham crackers, agar sauce.	Coffee, condensed milk, hamburger, graham crackers, agar sauce.	Coffee, condensed milk, peanut butter, crackers, agar sauce.

A clear demarcation of the feces was many times prevented by soft or scanty stools. To overcome constipation, to insure frequent and copious bowel movements and to obtain a sharp marking of feces, agar was fed in all of the described tests. It takes considerable determination for a normal person to eat 10 gm. of shredded agar three times a day for two weeks, and consequently trouble was encountered in attempting to feed such an amount to disinterested insane persons. Patient G. G. was induced to eat 7 gm. of ground shredded agar at each meal when it was mixed with peanut butter and butterine, and spread on crackers. A number of failures followed the attempts to feed agar in this way to other patients. Patient A. S. took the agar when it was ground and coated with crystal sugar. The most palatable form of agar which has yet been prepared by us and which was used in the tests on Patients S. K. and F. L., was made by passing shredded agar through a sausage-grinder, moistening it with water and mixing with ground apple-sauce. This leaves the small pieces of agar tender enough to take away the straw-like consistency.



Urine and feces collector used in dementia praecox metabolism tests. *A* shows galvanized shelf which holds the feces, allowing urine to pass through; *B*, collector in canvas case.

Much difficulty was at first encountered in the collection of urine and feces separately or at all. All tests were made on women patients. Many refused to use either bed-pan or urinal, or both. If the patient did not object to using the bed-pan and urinal, often the collections were spoiled by the passage of both urine and feces at once into the bed-pan. These difficulties were all overcome by the construction of a collector, which is shown in the illustration.

Immediately after the passage of the excretions, the urine was drawn off into a bottle and the collector put into the canvas case and brought to the laboratory. Carmin was used as feces marker in obtaining the feces resulting from the test periods of feeding. The difficulty of getting the patient's bladder completely emptied at the end of each day was not overcome.

The patient in each case was kept out of bed all day and taken daily for a walk of about two miles in the open air. All of the cases were examples of dementia praecox. Patients G. G., A. S. and F. L. were of the chronic type. Patients S. K. and M. P. were of the subsiding acute type.

I am indebted to Dr. H. D. Singer and Dr. S. N. Clark for the following summaries of the cases.

REPORT OF CASES

CHRONIC STAGE OF HEBEPHRENIC DEMENTIA PRAECOX

CASE 1.—Patient F. L. has been in the Kankakee State Hosptal since January, 1904, and but little information is obtainable concerning her early life and the onset of the mental disorder. Her mother had been "slightly insane" for from fifteen to eighteen years. The patient was thought normal, married and had two children. In 1901, at the age of 32, she became depressed over the death of a chlld and following this became gradually more restless, excited and abusive and was treated at this hospital from August to December of that year. She was readmitted in January, 1904, and when received at the hospital was clear mentally, restless, irritable, experienced sense-falsifications with occasional violent reaction, and felt herself under outside influence. This early period of episodic restlessness, excitement and irritability apparently continued until 1907, when it was noted for the first time that she had become demented. She has since been indifferent, inactive and careless and untidy in appearance, with occasional episodes of noisy restlessness lasting a few days or weeks. She appears smiling, occasionally laughs and shows some stereotyped mannerisms such as suddenly pulling up her clothing. The metabolism test was performed in November and December, 1913, while patient was in a period of complete quiescence.

CASE 2.—Patient G. G., aged 25, was admitted to the Kankakee State Hospital on Aug. 22, 1912, with but scanty anamnesis. The mental picture had persisted with but little change for at least four years at that time. It was characterized by a general lack of interest in her surroundings with occasional outbursts of unexplained irritability, neglect of personal appearance and occasional uncleanliness. It was impossible to employ her steadily and for the most part she sat smiling to herself or wandered slowly and aimlessly. She appeared to be quite clear and to recognize her surroundings, but gave no connected information. Speech and actions were desultory with many oddities and stereotypies. There were no evidences of disease of the body organs. When admitted, the patient showed hemic murmur, but it has since disappeared. At the time of the test the picture was as described above and there has been no material alteration since.

CASE 3.—Patient A. S. was admitted to the Kankakee State Hospital, Dec. 9, 1910, aged 23. Very little is known of her early life, but she was considered an average child and graduated from common school at 14. She then went to work in a factory, but about two years later quietly gave it up and remained more or less indifferently at home. She became more and more careless and indifferent, developed certain peculiarities, such as touching various objects, putting odds and ends in her mouth, wandering away from home, etc., and probably experienced some sense falsifications, but without acute reactions. When admitted presented some physical signs suggestive of a tuberculous process in the lung, but there have been no cough, fever or loss of weight to suggest an active condition. The mental picture has been one of marked absence of spontaneity, a smiling compliance with all requests, indifference to personal appearance and cleanliness, and to the situation, in spite of full clearness. Answers to questions show much desultoriness of thought with some *vorbeireden*. Except for a

period of a few weeks beginning in February, 1911, when she became semistuporous, had to be spoon-fed and was more or less inaccessible though without rigidity of muscles, the picture outlined above has persisted unchanged. The metabolism test was made in December, 1912, while the patient was in this stationary condition.

SUBSIDING STAGE OF ACUTE KATATONIC DEMENTIA PRAECOX

CASE 4.—Patient M. P. was admitted to the Kankakee State Hospital, Dec. 28, 1912. Her mother has suffered from some psychosis, probably dementia praecox, since 1907. The patient was born in 1882 and is described as bright intellectually, with special interest in music, but always very nervous, self-conscious and irritable. She had no friends or confidants, was much alone and professed a hatred for male society. During the summer of 1912 she became depressed and later more restless with many odd acts and increasing inaccessibility. She also experienced auditory hallucinations. In December, 1912, she passed into a state of mutism and complete inactivity with some waxy rigidity of limbs, and was in this condition when admitted. The metabolism studies were undertaken in February, 1913, during this phase of katatonic stupor. During the earlier part of the tests she remained entirely mute and inaccessible, but towards the end of the two weeks she began to be slightly more active and to obey simple requests. The improvement continued subsequently but the patient has remained stilted and affected in speech and act, more or less indifferent to her surroundings, her friends, and her personal cleanliness, with outbursts of unmotived restless irritability and even violence, which occasionally interrupt a usual appearance of smiling indifference.

CASE 5.—Patient S. K. was admitted to the Kankakee State Hospital, July 25, 1913, aged 20. This patient is Bohemian and it has been impossible to obtain much anamnesis. She is described as an unusually bright child with no previous illness. In July, 1913, she became depressed and was admitted in a condition of marked katatonic stupor with absolute mutism and entire lack of spontaneous movement, with often some waxy rigidity and command automatism. Food was swallowed when placed in the mouth, but the patient paid no attention to flies or to other stimuli. August 1 she spoke for the first time since admission, but did not speak again before the 15th. The metabolism test was begun August 16 and continued until August 29, by which time it was possible to obtain a few answers to questions. She has since improved steadily and was allowed to return to her friends Nov. 16, 1913, having gained 23 pounds, though she still showed a lack of spontaneity with some vacuity and a failure to grasp the fact and nature of her illness. Conversation with her was very difficult owing to language differences.

Analyses of a composite of the daily food, finely ground and mixed, were made for nitrogen, sulphur, phosphorus, calcium and magnesium. The urine for the entire period was well mixed and analyses made of the mixture for the different forms of nitrogen and sulphur, in addition to the analyses made on the food. A composite of the total feces of the period was made in each case, and the same analyses made as on the food. The methods used are the following: Kjeldahl method for nitrogen, Folin's sodium-peroxid and Benedict's methods for total sulphur, Folin's methods for total sulphates and inorganic sulphates in urine, McCrudden's method for calcium and magnesium, Benedict's and Gephart's method for urea, Folin's method for ammonia, Folin-Shaffer method for uric acid and Folin's colorimetric method for creatinin. The official method of the Association of Official Agricultural Chemists was used to

determine the phosphorus after its oxidation. The oxidation in the case of the urine was with aqua regia, and in the case of foods and feces by ignition followed by digestion with concentrated nitric acid for four hours.

The accompanying tables contain the results of the five tests.

TABLE 2.—NITROGEN EXPRESSED IN GRAMS PER DAY

Type	Patient	Length of Test Days	Food	Urine	Feces	Balance
Chronic..	F. L.	7	19.0230	7.6966	1.1616	10.1648+
	G. G.	6	18.2122	10.5703	1.5340	6.1078+
	A. S.	6	12.5496	11.8703	1.9313	1.2520—
Subsiding, acute..	M. P.	4	16.0290	7.2058	0.7714	8.0518+
	S. K.	8	10.4437	7.1181	0.9619	2.3637+

TABLE 3.—DISTRIBUTION OF URINARY NITROGEN EXPRESSED IN GRAMS PER DAY

Type	Patient	Nitrogen Total	Urea	Ammonia	Creatinin	Uric Acid
Chronic..	F. L.	7.6966	6.8366	0.1514	0.3674	0.1433
	G. G.	10.5703	9.5321	0.2328	0.1093	0.0722
	A. S.	11.8703	10.5489	0.4349	0.2489	0.0423
Subsiding, acute..	M. P.	7.2058	5.3741	0.4426	0.1245	0.1035
	S. K.	7.1181	5.8038†	1.0097	0.3382	0.0738

TABLE 4.—DISTRIBUTION OF URINARY NITROGEN EXPRESSED IN PERCENTAGE OF TOTAL NITROGEN

Type	Patient	Nitrogen Total	Urea	Ammonia	Creatinin	Uric Acid
Chronic..	F. L.	100	88.87	1.97	4.78	1.86
	G. G.	100	90.17	2.00	1.03	0.68
	A. S.	100	88.82	3.66	2.09	0.37
Subsiding, acute..	M. P.	100	74.70	6.15	1.73	1.44
	S. K.	100	81.83†	14.19	4.78	1.04

† Determination was made on urine several days old; therefore the results are probably high.

TABLE 5.—EXCRETION OF SULPHUR EXPRESSED IN GRAMS PER DAY

Type	Patient	Length of Test Days	Food	Urine	Feces	Balance
Chronic..	L. F.	7	1.9620	0.7155	0.4395	0.8070+
	G. G.	6	1.7216	0.3143	0.4378	0.9695+
	A. S.	6	1.0174	0.7691	0.4210	0.1727—
Subsiding, acute..	M. P.	4	2.1645	0.9768	0.5282	0.6895+
	S. K.	8	0.9756	0.5930	0.5233	0.1407—

TABLE 6.—DISTRIBUTION OF URINARY SULPHUR EXPRESSED IN GRAMS PER DAY

Type	Patient	Sulphur Total	Total Sulphate	Inorganic Sulphate	Neutral	Ethereal Sulphate
Chronic..	F. L.	0.7155	0.6321	0.5469	0.0834	0.0852
	G. G.	0.3142	0.2293	0.2756	0.0847	
	A. S.	0.7691	0.4550	0.4421	0.3140	0.0129
Subsiding, acute..	M. P.	0.9768	0.2858	0.2936	0.6910	
	S. K.	0.5930	0.4631	0.4291	0.1299	0.0340

TABLE 7.—Distribution of Urinary Sulphur Expressed in Per Cent. of Total Sulphur

Type	Patient	Sulphur: Total	Total Sulphate	Inorganic Sulphate	Neutral	Ethereal Sulphate
Chronic..	F. L.	100	88.30	76.30	11.64	11.90
	G. G.	100	72.99	87.72	27.02	
	A. S.	100	59.15	57.47	40.82	1.68
Subsiding, acute..	M. P.	100	29.26	30.06	70.76	
	S. K.	100	78.12	72.39	21.91	6.08

TABLE 8.—Phosphorus Expressed in Grams Per Day

Type	Patient	Length of Test: Days	Food	Urine	Feces	Balance
Chronic..	F. L.	7	1.2825	0.4111	0.3798	0.4916+
	G. G.	6	2.2200	0.5369	1.1810	0.5021+
	A. S.	6	1.2960	0.7193	0.5676	0.0091+
Subsiding, acute..	M. P.	4	1.3552	.....	0.2474	..
	S. K.	8	0.7625	0.3393	0.6347	0.2115—

TABLE 9.—Calcium Expressed in Grams Per Day

Type	Patient	Length of Test: Days	Food	Urine	Feces	Balance
Chronic..	F. L.	7	1.1003	0.2731	0.6978	0.1294+
	G. G.	6	2.4045	0.2272	1.8988	0.2785+
	A. S.	6	1.3068	0.2794	0.8368	0.1906+
Subsiding, acute..	M. P.	4	1.0960	0.5954	0.3032	0.1974+
	S. K.	8	0.6699	0.2472	0.4314	0.0087—

TABLE 10.—Magnesium Expressed in Grams Per Day

Type	Patient	Length of Test: Days	Food	Urine	Feces	Balance
Chronic..	F. L.	7	0.6789	0.1281	0.2875	0.2633+
	G. G.	6	0.6313	0.1002	0.4931	0.0380+
	A. S.	6	0.3521	0.1031	0.2594	0.0104—
Subsiding, acute..	M. P.	4	0.4841	0.1161	0.1635	0.2045+
	S. K.	8	0.5356	0.0872	0.3302	0.1182+

TABLE 11.—Distribution of Various Elements Expressed in Relation to Nitrogen Valued at 100

Type	Patient	Food	Urine	Feces	Urine and Feces	Balance
		Sulphur:				
Chronic..	F. L.	10.32	9.29	37.82	13.04	7.94+
	G. G.	9.45	2.97	28.54	6.21	15.87+
	A. S.	8.11	6.48	21.80	8.62	13.79+
Subsiding, acute..	M. P.	13.50	13.56	68.45	18.87	8.56+
	S. K.	9.34	8.33	54.42	13.82	5.95—
		Phosphorus:				
Chronic..	F. L.	6.73	5.34	32.68	8.93	4.84+
	G. G.	12.19	5.08	76.78	14.20	8.22+
	A. S.	10.32	6.06	29.40	9.32	0.73—
Subsiding, acute..	M. P.	8.45	.....	32.06	.....	
	S. K.	7.30	4.77	66.01	12.06	8.95—
		Calcium:				
Chronic..	F. L.	5.78	3.55	60.05	10.96	1.27+
	G. G.	13.20	2.15	123.78	17.57	4.56+
	A. S.	10.41	2.35	43.34	8.08	15.23—
Subsiding, acute..	M. P.	6.84	8.26	39.29	11.27	2.45+
	S. K.	6.42	3.47	44.86	8.40	0.37—
		Magnesium:				
Chronic..	F. L.	3.57	1.66	24.74	4.69	2.59+
	G. G.	34.66	0.95	32.14	4.90	0.62+
	A. S.	2.80	0.87	13.43	2.62	0.83+
Subsiding, acute..	M. P.	3.02	1.61	21.19	3.50	2.54+
	S. K.	5.13	1.22	34.34	5.17	4.99+

DISCUSSION OF RESULTS

Total Nitrogen.—Table 2 indicates nothing of particular interest concerning the nitrogen distribution. With an intake of 12.5 gm. of nitrogen as in the case of Patient A. S., a negative balance is hardly to be expected. The excessive amount of nitrogen in the urine, which was responsible for this negative balance is more or less constant for this patient as shown in a previous test.[6]

Nitrogen Partition, Urea Nitrogen.—The urea nitrogen in the several cases varied from 5.37 to 9.53 gm. daily. These values are within the range of the normal urea output, but nearer the minimum than the maximum limit. When the patients are grouped according to the two classes of dementia praecox, one is immediately struck with the fact that, as far as the urea nitrogen is concerned, each class seemed to have a field of variation of its own. The chronic cases excreted from 6.84 to 10.55 and the acute cases from 5.37 to 5.80 gm. of urea nitrogen. The same class difference is indicated in Table 4 in which the urea nitrogen is expressed in per cent. of the total urinary nitrogen. In the chronic cases it is from 88.8 to 90.2, while in the acute cases it is from 74.7 to 81.8 per cent.

Folin[7] shows that the urea output is governed to some extent by the protein intake. Folin fed 118 gm. of protein and found a urea-nitrogen output of 14.7 gm. which constituted 87.5 per cent. of the total urinary nitrogen. When he fed 6 gm. of protein, the urea-nitrogen excretion decreased to 2.2 gm., making up only 61.7 per cent. of the total urinary nitrogen. The question now arises as to whether or not in our cases the class differences in the output of urea nitrogen in grams and in per cent. were not due to a difference in the nitrogen intake. If this were true, there should be no constant difference between the two classes of patients in the number of grams of urea nitrogen excreted per gram of nitrogen ingested, and in the per cent. of urea nitrogen making up the total urinary nitrogen per gram of nitrogen ingested. That this is the case in both of the relations is shown by the following figures for Patients F. L., G. G., A. S., M. P. and S. K., respectively, 0.359, 0.523, 0.841, 0.335 and 0.556 gm. of urea nitrogen per gram of nitrogen ingested, and 4.67, 4.95, 7.08, 4.66 and 7.84 per cent. of total urinary nitrogen in the form of urea nitrogen per gram of the total nitrogen intake. Since these figures do not show any definite distinction between the two classes of patients, and since it is well known that the urea nitrogen is governed to some extent by the nitrogen intake, we must conclude that in this test

6. Ross, Ellison L.: Some Forms of Urinary Nitrogen Affected by the Administration of Desiccated Thyroid to Dementia Praecox Patients, THE ARCHIVES INT. MED., 1913, xii, 746.

7. Folin: Quoted by Lusk in Science of Nutrition, p. 138.

the differences in urea excretions were due to the differences in the nitrogen intake.

Ammonia Nitrogen.—Normally ammonia nitrogen varies from about 0.2 to 1 gm. per day. The amount varies in normal individuals with the diet, depending on the amount of protein ingested and on the amount of acid-forming constituents and alkali metals of the diet. In pathological cases excessive ammonia output indicates an increased acid formation within the organism. Von Noorden[8] states that when the ammonia nitrogen of the urine does not exceed from 8 to 10 per cent. of the total nitrogen intake it cannot be said to be abnormal.

In this test the ammonia nitrogen varied from 0.15 to 1.01 gm. per day, entirely within the normal so far as the absolute quantities are concerned. The difference between the two classes of dementia praecox in this is distinct, but not great enough to prohibit the explanation of the difference on the grounds of differences in the character of the food.

In Table 4 the ammonia nitrogen is expressed in per cent. of the total nitrogen of the urine. Expressed in this way, ammonia nitrogen makes up from 2.0 to 14.2 per cent. of the total amount in the urine. Von Noorden[8] considers this manner of expressing the amount of ammonia nitrogen of no value. That this is true is indicated by Folin's[7] test, cited before, in which 118 gm. were fed with an output of 16.8 gm. of urinary nitrogen and 0.49 gm. of ammonia nitrogen, making up 3.0 per cent. of the urinary nitrogen, whereas when 6 gm. of protein were fed, 3.6 gm. of nitrogen appeared in the urine, of which 0.42 gm., or 11.3 per cent. was ammonia nitrogen. In these two tests there were about equal quantities of ammonia nitrogen expressed in grams, but nearly four times as much in the second test as in the first, if measured by the per cent. of the total urinary nitrogen, which made up from 60 to 90 per cent. of the variable urea nitrogen. It is an interesting fact, however, that in the acute cases a greater per cent. of nitrogen in the form of ammonia nitrogen was excreted than in the chronic cases.

If the ammonia nitrogen were expressed in per cent. of the total nitrogen ingested we would have for Patients F. L., G. G., A. S., M. P., and S. K., the following values: 0.80, 1.28, 3.46, 2.76, and 9.71 per cent. These figures show a tendency in the acute cases to the excretion of the greater amount of ammonia nitrogen. The average of the values for the acute cases, 6.23 per cent., is larger than the average of any two cases in the chronic group and considerably larger than the average of all of those in the chronic group, 1.85 per cent. According to Von Noorden this variation not being outside of from 8 to 10 per cent., could not be said to be abnormal.

8. Von Noorden: Metabolism and Practical Medicine, i, 106.

Creatinin and Uric Acid Nitrogen.—No distinction can be detected between the two classes of patients by their output of creatinin and uric acid nitrogen. The amounts of creatinin and uric acid nitrogen are within the range of normal persons, according to Schaffer,[9] Hawk,[10] Neubauer, P. Munk and C. Voit,[11] Van Noorden[12] and Folin.[13]

Total Sulphur.—Table 5 indicates the distribution of the total sulphur. The intake varied from 0.97 to 2.16 gm. per day. The urinary sulphur had a greater variation, from 0.31 to 0.98 gm. per day. The fecal sulphur was remarkably constant for the two classes of patients. In the chronic class it was from 0.42 to 0.44 gm. and in the acute class from 0.52 to 0.53 gm. per day. Undoubtedly the greater part of this sulphur in the feces was in the indigestible agar, which contains about 1 per cent. of sulphur. The balances of sulphur are such as might be expected to accompany the nitrogen balances given in Table 2, except in the case of Patient S. K., who showed a positive nitrogen balance, but a negative sulphur balance. Although the character of the diet given in Table 1 is usually considered a well-balanced one, the analysis of the food and feces seems to indicate that the available sulphur occurred in an insufficient quantity in the diet of S. K.

Table 11 indicates the sulphur distribution relative to the total nitrogen distribution, the latter taken as a standard being evaluated as 100. The sulphur-nitrogen relation in the foods of the five patients varied considerably—from 8.11 to 13.50 per cent. This variation is undoubtedly due to the agar, which is poor in nitrogen and contains about 1 per cent. of sulphur.

The sulphur-nitrogen relation for the urines is interesting in the wide range of variation of from 2.97 to 13.56 per cent. The same large variation exists for the feces and for the total outgo. In the case of the urine, feces and total outgo, the sulphur-nitrogen relation of the two classes of patients materially differs. The average of all of the values or any two of the values for the chronic cases is less than the average for the acute cases. It therefore may be concluded from these tests that in the subsiding acute cases of dementia praecox there is a tendency to excrete more sulphur in proportion to nitrogen in both urine and feces than in the cases of chronic dementia praecox. Whether

9. Shaffer: Quoted by P. B. Hawk in Practical Physiological Chemistry, Ed. 3, p. 270.

10. Hawk: Quoted by P. B. Hawk in Practical Physiological Chemistry, Ed. 3, p. 266.

11. Neubauer, Munk P., and Voit, C.: Quoted by Von Noorden in Metabolism and Practical Medicine, i, p. 127.

12. Von Noorden: Metabolism and Practical Medicine, i, p. 115.

13. Folin: Quoted by Lusk in Science of Nutrition, pp. 138-364.

or not this tendency is outside of the limits of normal variation cannot be determined from the data available.

Sulphur Partition.—Total Sulphate-Sulphur.—The patients in this test excreted in the urine from 0.23 to 0.63 gm. of sulphur in the form of sulphates. These amounts made up from 29.26 to 88.30 per cent. of the total sulphur in the urine. While the total sulphate-sulphur of the urine is dependent on both diet and physical condition of the subject, Hawk[14] states that normally about 2.5 gm. of sulphuric acid or about 0.8 gm. of sulphur are excreted per day in the sulphate form. Folin[5] gives the total sulphate-sulphur output of two normal cases on a purin-free diet. The first case gave an average of 1.14 gm. or 94.2 per cent. of the total urinary sulphur. The second case gave 0.87 gm. or 86.9 per cent. of the total urinary sulphur. Mandel and Lusk[16] found that a normal subject, on a six-day test, excreted, for every 100 gm. of nitrogen ingested, an average of 6.24 gm. of sulphur in the form of sulphates. Our patients, taken in the order in which the cases are arranged in the tables, excreted, for every 100 gm. of nitrogen ingested, 3.32, 1.26, 3.62, 1.83 and 4.45, or an average of 2.90 gm. of sulphur in the form of sulphates. While the above comparisons, made with the total sulphate output in these cases of dementia praecox, have not been closely comparable for reasons of differences of diet, subjects and conditions of subjects, they have shown that the patients of our test did not excrete normal amounts of sulphate sulphur.

Inorganic Sulphates: Tables 6 and 7 show the amount of sulphur in the form of inorganic sulphates in the urine to have varied from 0.27 to 0.55 gm. per day, or from 30.06 to 87.72 per cent. of the total urinary sulphur. There is also a suggestion of a difference between the two classes of dementia praecox in the amounts of inorganic sulphates excreted. The average of the two lowest values in the chronic cases is 0.3588 gm., or 72.59 per cent. of the total urinary sulphur, and the average in all three cases is 0.4215 gm., or 73.83 per cent. of the total urinary sulphur, while the average in the subsiding acute cases is 0.361 gm., or 51.22 per cent. of the total. There is an overlapping of values in the two classes, so that the class difference must be considered small. As to the normality of the values as a whole for the inorganic sulphate sulphur output, there is little question. The only data at hand for comparison are those of Folin.[15] On a purin-free diet, Folin's patients averaged 1.028 gm., or 86.2 per cent., and 0.80 gm., or 78.7 per cent. of the total sulphur. According to these figures the chronic

14. Hawk: Practical Physiological Chemistry, Ed. 3, p. 291.

15. Folin: Quoted by Lusk in Science of Nutrition, p. 364.

16. Mandel and Lusk: Quoted by Von Noorden in Metabolism and Practical Medicine, iii, 613.

patient's output of inorganic sulphate would be nearly normal so far as the percentage of the total sulphur is concerned, but low in absolute quantities. Compared in the same way, in the acute cases the patients were below normal both in absolute weight of inorganic sulphate sulphur and in its relation to the total urinary sulphur.

Neutral-Sulphur.—The neutral-sulphur output of our patients is especially interesting in that it confirms Pighini's[1] findings. The absolute amount varies from 0.0834 to 0.6910 gm., making up from 11.64 to 70.76 per cent. of the total urinary sulphur. While there is some overlapping of values in the two classes of patients, there seems to be a distinct tendency in the acute cases to the excretion of the greater amount of neutral-sulphur. The average of the two highest values in the chronic class is 0.1883 gm., making up 33.92 per cent. of the total sulphur, and the average of all three chronic cases 0.1607 gm., or 26.49 per cent. of the total sulphur of the urine, while the average output in the acute cases was 0.4104 gm., or 46.33 per cent. of the total urinary sulphur.

Sherman[17] states that normally from 5 to 15 per cent. of the total urinary sulphur is neutral-sulphur. Von Noorden finds that the neutral sulphur normally makes up from 14 to 25 per cent. of the total urinary sulphur. Folin's cases averaged 5.8 and 13.1 per cent., or 0.14 and 0.10 gm., of neutral-sulphur. These figures indicate that in the chronic cases an amount of neutral-sulphur very close to the limit of normal subjects was excreted, and that the acute cases were quite abnormal in this respect.

Ethereal Sulphates.—The data on the ethereal sulphate-sulphur output are not satisfactory or sufficient to be of any considerable importance. The tendency seems to be toward a low percentage for this form of sulphur.

Phosphorus.—Table 8 gives the distribution of phosphorus in the food, urine, feces, and the balance. The intake varied from 0.76 to 2.22 gm. Sherman[18] states that in normal subjects about 1.2 gm. are necessary for a phosphorus balance to result, but that a phosphorus balance has been obtained on as low as 0.90 gm. per day. From these facts it is evident that Patient S. K. did not receive sufficient phosphorus for a normal person. Therefore the negative phosphorus balance in this patient was to have been expected. In the urine the phosphorus seems to have been more normal in all cases. Von Noorden[19] states that normally the ratio $P_2O_5 : N = 1 : 7$. In our cases the ratio varies from 1:7.1 to 1:9.1.

17. Sherman: Chemistry of Food and Nutrition, p. 268.
18. Sherman: Chemistry of Food and Nutrition, p. 278.
19. Von Noorden: Metabolism and Practical Medicine, iii, 817.

Calcium.—The calcium distribution shown in Table 9 is relatively a normal one. The intake varied from 0.6699 to 2.4045 gm. per day. Sherman[20] states that the normal body requires from 0.7 to 1.0 gm. of CaO, or expressed in terms of Ca, from 0.5 to 0.7 gm. per day. The calcium intake of Patient S. K. was the only one which approached the minimum limit. That it was her smallest calcium requirement is shown by her very small negative balance. The amount of calcium in the urine varied from 0.2272 to 0.5954 gm., which, according to von Noorden,[21] is normal. No difference between the two classes of patients can be detected from the absolute amounts excreted or the amounts relative to the nitrogen given in Table 2.

Magnesium.—Renvall[22] asserts that man normally needs 0.45 gm. of magnesium per day. Langworthy[23] estimates the normal bodily requirement of magnesium to be from 0.18 to 0.30 gm. per day. Our patients received from 0.3521 to 0.6789 gm. per day. According to Langworthy's standard all patients received sufficient magnesium. According to Renvall's standard all but one of our patients had a sufficiency of this element and that patient had a small negative balance. The magnesium content of the urines was quite constant, varying from 0.0872 to 0.1281 gm. The feces content was quite variable because of the relative richness of the agar in the food. The balances show nothing of importance. The absolute amounts and the relative amounts of magnesium to the nitrogen in the urines, feces and balances do not show any differences between the two classes of dementia praecox.

SUMMARY

Five cases of dementia praecox, three of them in a chronic and two in a subsiding acute phase of the disease, were used in the metabolism tests. Over a period of from four to eight days the exact income and outgo of total nitrogen, different forms of nitrogen, total sulphur, different forms of sulphur, phosphorus, calcium and magnesium were determined.

The metabolism of total nitrogen was found to be within the limits of normal with the possible exception of one case.

The urea nitrogen of the urine was variable but remained normal.

The ammonia nitrogen of the urine varied within the limits found in normal cases. In the acute cases a tendency was exhibited to excrete more of this form of nitrogen than in the other class of patients.

20. Sherman: Chemistry of Food and Nutrition, p. 288.

21. Von Noorden: Metabolism and Practical Medicine, iii, 39.

22. Renvall: Quoted by von Noorden in Metabolism and Practical Medicine, i, 428.

23. Langworthy: Quoted by E. B. Forbes in Bull. Ohio Experiment Station, No. 201, p. 165.

The amounts of creatinin and uric acid nitrogen obtained in these cases of dementia praecox coincide with the normal.

The metabolism of total sulphur is considered normal, with the acute cases showing a greater sulphur excretion, both in urine and feces, than the other class of patients.

The total sulphate-sulphur output, according to the data on normal cases cited by authorities, was below normal.

The inorganic sulphate-sulphur of the urine, according to data on normal subjects, was below normal in absolute quantities in both classes of patients, and lowest in the case of the acute class. The amounts of this form of sulphur expressed in percentage of the total urinary sulphur, were about normal for the chronic class but below normal for the acute group.

The urinary neutral-sulphur was practically normal for the chronic cases, but much above normal in the subsiding acute cases.

The ethereal sulphate findings were negative.

As to the meaning of these positive findings on the sulphur metabolism there is little question. In the chronic cases there was normal total sulphur, practically normal neutral sulphur, below normal total sulphate and possibly below normal inorganic sulphate. In the acute cases we have a normal, but a maximum normal, excretion of total sulphur, subnormal total sulphate, subnormal inorganic sulphate and supernormal neutral sulphur. E. Salkowski and Rudenko[24] state the well-known fact that an increased neutral-sulphur output at the expense of the sulphates is an indication of reduced power of tissue oxidation. Therefore it must be concluded from the sulphur data that in the acute cases the patients had lost to a certain degree their normal powers of oxidation. Also this is suggested in the patients in the chronic class by the subnormal sulphate output. That a reduced power of oxidation should occur in cases of acute dementia praecox is not surprising, since seemingly every bodily activity is decreased. That indol-acetic acid is very frequently found in the urines of dementia praecox patients[5] is evidence of a diminished power of oxidation.

The findings on phosphorus, calcium and magnesium were negative.

CONCLUSIONS

In these cases of dementia praecox the data show the following facts:

1. The metabolism of nitrogen, phosphorus, calcium and magnesium was normal in both classes of patients.

24. Salkowski, E., and Rudenko: Quoted by von Noorden in Metabolism and Practical Medicine, ii, 355.

2. The metabolism of sulphur, except in the excessive total sulphate output and possibly the inorganic sulphate output, was normal for the chronic cases.

3. The metabolism of sulphur in the acute cases was abnormal in that the excretion of total sulphur was maximum normal, the total sulphate and inorganic sulphate output were subnormal and the neutral sulphur of the urine was above normal.

4. The abnormalities in the sulphur metabolism of the acute forms indicate a reduced power of metabolic oxidation. The fewer and less pronounced abnormalities of sulphur metabolism in the chronic group suggest a similar, though less extensive deficiency, than in the case of the acute group.